National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Department
biomedical engineering

Microprocessor Engineering

Working program of basic discipline (Silabus)

Requisites for basic discipline	
Level of higher education	***First (bachelor's)***
Branch of knowledge	*16 Chemical engineering and Bioengineering*
Specialty	*163 Biomedical Engineering*
Educational program	*Medical Engineering*
Discipline status	*Mandatory discipline*
Form of study	*full-time / day / mixed / remote*
Year of preparation, semester	*4th course, autumn semester*
The scope of discipline	*6 ECTS credits / 180 hours*
Semester control / Control measures	*Exam, Modular Test Work, Calculation and Graphic Work*
Lessons schedule	*According to the schedule on the site http://rozklad.kpi.ua/*
Language of instruction	*English*
Information about course leader / teachers	***Lecturer:*** *Doctor of Technical Sciences, Associate Professor, Head Department of BME Shlykov Vladyslav Valentynovych, e-mail: v.shlykov@kpi.ua, Telegram: https://t.me/vshlykov* ***Practical:*** *Doctor of Technical Sciences, Associate Professor, Head Department of BME Shlykov Vladyslav Valentynovych, e-mail: v.shlykov@kpi.ua, Zoom: 759 024 5108, code 202202*
Course placement	*Platform «Sikorsky» - course «Microprocessor Engineering» (dx34it)*

Distribution of hours

Semester	Lectures	Practical	Laboratory	Independent Work
autumn semester	*36*	*18*	*36*	*90*

Curriculum of the discipline

1. Description of the discipline, its purpose, subject of study and learning outcomes

The main purpose of the discipline "Microprocessor Engineering" is to form students' ability to solve complex specialized problems and practical problems of architecture of computer and microprocessor systems, which involves the use of theories and scientific methods of analog and digital electronics, software and hardware for medical devices and systems.

The discipline "Microprocessor Engineering" studies the application of methods of analog and digital electronics, architecture of computer and microprocessor systems, software and hardware for the design of medical devices and systems to solve problems related to the development and engineering of biological and medical devices and systems that include single-chip microprocessors and microcontrollers.

Skills are required to study the discipline:

1. Knowledge of a foreign language;
2. Fundamentals of computer science regarding the organization of numerical calculation methods;
3. General methods for building digital systems;

4. Technological bases of digital technology;
5. Analysis and synthesis of digital circuits of combinational and sequential type;
6. Construction of functional units of digital diagnostic and physiotherapeutic devices.
7. Object-oriented programming in the C/C++ language.

General competencies *(OPP was put into effect by the Rector's Order NON/434/2024 of 10.06.2024 p.):*

ZK 1 - *Ability to apply knowledge in practical situations.*
ZK 2 *- Knowledge and understanding of the subject area and understanding of professional activities.*
ZK 3 *- Ability to communicate in the official national language both orally and in writing.*
ZK 5 *- Ability to conduct research at an appropriate level.*
ZK 10 *- Skills in conducting safe activities.*

Special (professional) competencies *(OPP was put into effect by the Rector's Order NON/434/2024 of 10.06.2024 p.):*

FK 1 *- Ability to apply engineering software packages for research, analysis, processing, and presentation of results, as well as for automated design of medical devices and systems.*
FK 2 *- Ability to provide engineering and technical expertise in the planning, development, evaluation, and specification of medical equipment.*
FK 7 *- Ability to plan, design, develop, install, operate, maintain, service, control, and coordinate the repair of devices, equipment, and systems for prevention, diagnosis, treatment, and rehabilitation used in hospitals and research institutes.*
FK 12 *- Ability to ensure and monitor compliance with safety and biomedical ethics when working with medical equipment.*

The program learning outcomes after studying the discipline "Microprocessor Engineering" are *(OPP was put into effect by the Rector's Order NON/434/2024 of 10.06.2024 p.):*

PRN 2 - *Formulate logical conclusions and reasoned recommendations regarding the assessment, operation, and implementation of biotechnical, medical-technical, and bioengineering tools and methods.*
PRN 4 *- Apply the provisions of regulatory and technical documents governing the procedure for product certification, production certification.*
PRN 7 *- Provide engineering support, service, and technical maintenance during the operation of laboratory analytical equipment, medical diagnostic and therapeutic complexes and systems in accordance with the rules established by technical documentation and regulatory documents governing the procedures for commissioning, application, and repair of medical equipment, as well as to form the standard documentation by types of work according to the technical regulation on medical devices.*
PRN 12 *- Provide recommendations for selecting equipment to facilitate diagnosis and treatment.*
PRN 18 *- Understanding of fundamental-applied, medical-physical, and physico-chemical principles governing the functioning of biological objects, as well as bioengineering fundamentals of technologies and equipment for researching human body processes.*

2. Prerequisites and postrequisites of the discipline (place in the structural and logical scheme of education according to the relevant educational program)

The discipline "Microprocessor Engineering" belongs to the cycle of professional training and has an interdisciplinary nature. It integrates according to its subject knowledge from other disciplines: analog and digital circuitry, object-oriented programming and more. According to the structural and logical scheme of the training program, the discipline "Microprocessor Engineering" is closely related to other disciplines of general and professional training: "Fundamentals of Informatics", "Electrical

Engineering and Electronic Devices", "Digital Circuitry", "Object-Oriented Programming". It is immediately preceded by the discipline "Digital Circuitry".

The acquired practical skills and acquired theoretical knowledge during the study of the discipline "Microprocessor Engineering" can be used in the future during the acquisition of academic disciplines:

- from the cycle of professional training (educational-professional program "Medical Engineering"): "Biomedical devices, apparatus and complexes";

- from elective disciplines (educational-professional program "Medical Engineering"): "Medical Equipment", "Development and operation of physiotherapeutic medical devices", " Information support for diagnostic and treatment processes of patients with lost limbs", "Design of medical information systems".

3. The content of the discipline

The main sections and topics that will be considered in the process of studying the course:

Section 1. General provisions for the construction of microprocessors.

Subject 1.1. Intel 8086 microprocessor. Coprocessor and arithmetic extension of the processor.

Subject 1.2. Program synchronization and timer control.

Section 2. Hardware of microprocessor systems.

Subject 2.1. Organization of memory and registers. Direct memory access.

Subject 2.2. Clock generator. Timers. Bus address and data.

Subject 2.3. Organization of I/O ports.

Subject 2.4. Interfaces of external devices for interaction with technological equipment.

Section 3. Software for microprocessor systems.

Subject 3.1. Interrupt controller. Organization of the mechanism of breaks.

Subject 3.2. Means of organization of exchange with external devices. The scheme of conclusions.

Subject 3.3. Application of microprocessor engineering in medicine.

Subject 3.4. Intel 8086 command system. Interrupt system. Memory addressing.

Subject 3.5. MASM tools for software development.

Section 4. Arduino processors architecture.

Subject 4.1. Memory and register organization for Arduino UNO.

Subject 4.2. Organization of I/O ports.

Subject 4.3. Selection and connection of sensors and sensors.

Section 5. Arduino processors software.

Subject 5.1. Arduino processor programming in C/C ++.

Subject 5.2. Arduino IDE software.

Subject 5.3. NI VISA components in LabVIEW 2010 for serial data I/O.

4. Training materials and resources

Basic literature:

1. *Шликов, В. В. Мікропроцесорна техніка. Практикум [Електронний ресурс]: навчальний посібник для студентів спеціальності 163 «Біомедична інженерія» та 152 «Метрологія та інформаційно-вимірювальна техніка» / В. В. Шликов ; КПІ ім. Ігоря Сікорського. – Київ : КПІ ім. Ігоря Сікорського, 2018. – 145 с.*
2. *Якименко Ю. І., Терещенко Т.О., Сокол Є.І., Жуйков В.Я., Петергеря Ю.С. Мікропроцесорна техніка: підручник для студ. вищ. техн. закл. освіти / за ред. Т.О. Терещенко / Міністерство освіти і науки України, НТУУ "КПІ". - Київ: Політехніка; Кондор, 2008. - 594 с.*

3. *Кирик В. В. Мікропроцесорна техніка: навч. посіб. / М-во освіти і науки України, НТУУ "КПІ" Київ: НТУУ "КПІ", 2014. - 183 с.*
4. *Терещенко Т.О., Петергеря Ю.С., Жуйков В.Я., Хохлов Ю.В., Мороз А.В. Електронний підручник «Мікропроцесори та мікроконтролери» для студентів напряму підготовки "Електроніка", "Електротехніка" та інших бакалаврат ів. Київ: НТУУ "КПІ", 2009.*
5. *Шликов В.В., Кисельова О.Г., Матвійчук А.О. Мікропроцесорна техника: Методичні вказівки до виконання лабораторних робіт для студентів напрямів підготовки 6.051402 «Біомедична інженерія», 6.051003 «Приладобудування» – К.: НТУУ «КПІ», 2014. – 123 с.*
6. *Shlykov, V. V. Microprocessor technics: workshop on discipline for students of specialties 163 «Biomedical Engineering» and 152 «Metrology and information-measuring technique» / V. V. Shlykov, Y. P. Stasyuk; Igor Sikorsky Kyiv Polytechnic Institute. – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2020. – 148 p.*

Additional literature:

1. *Коротинський А.П. Мікроконтролерні платформи. Arduino як інструмент систем автоматизації: практикум: навч. посіб. для здобувачів ступеня бакалавра за спеціальністю 174 «Автоматизація, комп'ютерно-інтегровані технології та робототехніка» / КПІ ім. Ігоря Сікорського; уклад.: А.П. Коротинський. – Київ: КПІ ім. Ігоря Сікорського, 2025. – 188 с.*
2. *Simon Monk, Programming Arduino: Getting Started with Sketches, 3rd Edition. Publisher: McGraw Hill TAB, 2022. - 178 P. ISBN-10: 1264676980*
3. *Jeremy Blum, Exploring Arduino: Tools and Techniques for Engineering Wizardry, 2nd Edition. Publisher: Wiley, 2019 - 512 P. ISBN-10: 1119405378.*
4. *Uma Rathore Bhatt, Assembly Language Programming with 8051 Microcontroller. Publisher: LAP LAMBERT Academic Publishing, 2016. - 72 P. ISBN-10: 3659865966.*
5. *Michael Predko, Handbook of Microcontrollers. Publisher: McGraw-Hill, 1998. - 861 P. ISBN-10: 0079137164.*

Educational content

5. Methods of mastering the discipline (educational component)

№ s/n	Subject	Program learning outcomes	The main tasks	
			Control measure	Deadline
1.	Intel 8086 microprocessor. Coprocessor and arithmetic extension of the processor: Part 1. Structure of the i8086 processor; Part 2. Arithmetic expansion of the processor for biotechnical systems.	PRN 2	Practical work 1 Laboratory work 1	1-2nd week тиждень
2.	Program synchronization and timer control: Part 1. Controlling the microprocessor timer using assembler software; Part 2. Software synchronization tools for maintenance during the operation of laboratory and analytical equipment.	PRN 7	Practical work 2	3rd week
3.	Organization of memory and registers. Direct memory access: Part 1. Direct memory access and its organization in a microprocessor;	PRN 12	Practical work 2	4th week

№ s/n	Subject	Program learning outcomes	The main tasks	
			Control measure	Deadline
	Part 2. Recommendations for the selection of equipment according to the technical requirements of memory organization.			
4.	Clock generator. Timers. Bus address and data: Part 1. Clock generator and timers in microprocessor systems; Part 2. Application and repair of medical equipment based on microprocessor systems.	PRN 7	Practical work 3	5th week
5.	Organization of I/O ports: Part 1. Organization of serial and parallel input/output ports; Part 2. Use of ports for input/output of signals that reflect the functioning of biological objects and electrical processes in the body.	PRN 18	Practical work 4 Laboratory work 2	6-7th week тиждень
6.	Interfaces of external devices for interaction with technological equipment: Part 1. Recommendations for organizing the interface of medical and bioengineering devices. Part 2. Procedure for certification and attestation of medical processors.	PRN 2 PRN 4	Practical work 4 Laboratory work 3	8th week
7.	Interrupt controller. Organization of the mechanism of breaks: Part 1. Organization of an interrupt mechanism for the interaction of a microprocessor with external devices. Part 2. Ensuring the interaction of a microprocessor with specialized biotechnical, medical-technical and bioengineering devices.	PRN 2	Practical work 5	9th week
8.	Means of organization of exchange with external devices. The scheme of conclusions: Part 1. Pinout diagram for organizing exchange with external devices; Part 2. Organizing exchange with external devices to ensure diagnosis and treatment.	PRN 12	Laboratory work 4	
9.	Application of microprocessor engineering in medicine: Part 1. Selection of microprocessor base for equipment providing diagnostics and treatment. Part 2. Technical recommendations for the use of microprocessor systems and	PRN 12 PRN 18	Practical work 5	10th week

№ s/n	Subject	Program learning outcomes	The main tasks	
			Control measure	Deadline
	equipment for the study of human body processes.			
10.	Intel 8086 command system. Interrupt system. Memory addressing: Part 1. Memory addressing and its organization in a microprocessor; Part 2. Recommendations for selecting equipment based on the technical requirements of memory organization.	PRN 2	Practical work 6 Laboratory work 5	11th week
11.	MASM tools for software development: Part 1. Development of software for a microprocessor using MASM tools; Part 2. Software synchronization tools for technical maintenance during the operation of laboratory and analytical equipment.	PRN 7	Laboratory work 6	12th week
12.	Memory and register organization for Arduino UNO: Part 1. Organization of memory and registers of the Arduino processor; Part 2. Recommendations for choosing equipment based on the technical requirements of memory organization.	PRN 12	Practical work 7	
13.	Organization of I/O ports: Part 1. Organization of serial and parallel input/output ports; Part 2. Use of ports for input/output of signals that reflect the functioning of biological objects and electrical processes in the body.	PRN 18	Laboratory work 7	13th week
14.	Selection and connection of sensors and sensors: Part 1. Connecting transducers and sensors to input/output ports; Part 2. Using transducers and sensors to input signals that reflect the functioning of biological objects and electrical processes in the body.	PRN 18	Practical work 7	
15.	Arduino processor programming in C/C ++: Part 1. Programming and operation of Arduino family processors; Part 2. Development of software for technical maintenance during the operation of medical diagnostic and therapeutic complexes.	PRN 7	Laboratory work 8	14th week
16.	Arduino IDE software: Part 1. Programming in the Arduino IDE environment in C/C++;	PRN 2	Practical work 8	

№ s/n	Subject	Program learning outcomes	The main tasks	
			Control measure	Deadline
	Part 2. Operation and implementation of biotechnical, medical and bioengineering devices using specialized software.			
17.	NI VISA components in LabVIEW 2010 for serial data I/O: Part 1. Input/output of data to a serial port in the LabVIEW design environment; Part 2. Using sensors in LabVIEW to input/output signals that reflect the functioning of biological objects and electrical processes in the body.	PRN 18	Laboratory work 9	15th week
18.	Modular control work		Practical work 9	
19.	Calculation and graphic work	PRN 2 PRN 7 PRN 18	Registration and submission of work	

Practical works

The main tasks of the cycle of practical works: consolidation in practice of the main provisions of the academic discipline "Microprocessor Engineering" by performing specially formulated tasks and real circuit-technical variants of biomedical equipment units, which are actually designed in the master's theses of students. The practical class includes conducting a control of knowledge, skills and abilities, solving problems of designing microprocessor systems with their discussion, solving control tasks, their verification and evaluation.

The grades received by the student for individual practical classes are entered into the journal of the study group and are taken into account when determining the final grade (rating) for this academic discipline.

№ s/n	Practical work topic	Duration in hours
1	i8086 processor structure	2
2	i8086 processor timer control	2
	Clock generator and timers in microprocessor systems	
3	Direct memory access and its organization in a microprocessor	2
4	Organization of serial input/output ports	2
	Interfaces of external devices for interaction with equipment	
5	Organization of the interrupt mechanism for interaction of the microprocessor with external devices	2
	Choosing a microprocessor base for equipment	
6	Memory addressing and its organization in the i8086 microprocessor	2
	Organization of memory and registers of the Arduino processor	
7	Connecting sensors and transducers to input/output ports	2
8	Programming in the Arduino IDE environment in C/C++	2
9	Module test work	2
Total hours		18

Laboratory works

The main tasks of the cycle of laboratory work: consolidation in practice of the main provisions of the academic discipline "Microprocessor Engineering" by performing specially formulated tasks and real circuit-technical variants of biomedical equipment units, which are actually designed in the master's theses of students. Practical work includes conducting a control of knowledge, skills and abilities, solving problems of designing microprocessor systems with their discussion, solving control tasks, their verification and evaluation.

The grades received by the student for individual laboratory work are entered into the journal of the study group and are taken into account when determining the final grade (rating) for this academic discipline.

№ s/n	*Practical work topic*	*Duration in hours*
1	*i8086 processor structure*	*4*
2	*i8086 processor timer control*	*4*
	Clock generator and timers in microprocessor systems	
3	*Direct memory access and its organization in a microprocessor*	*4*
4	*Organization of serial input/output ports*	*4*
	Interfaces of external devices for interaction with equipment	
5	*Organization of the interrupt mechanism for interaction of the microprocessor with external devices*	*4*
	Choosing a microprocessor base for equipment	
6	*Memory addressing and its organization in the i8086 microprocessor*	*4*
	Organization of memory and registers of the Arduino processor	
7	*Connecting sensors and transducers to input/output ports*	*4*
8	*Programming in the Arduino IDE environment in C/C++*	*4*
9	*To input/output data from serial port in LabVIEW*	*4*
Total hours		*36*

6. Independent student work

Types of independent work *(preparation for classroom lessons, calculations based on primary data obtained in laboratory classes, solving problems, writing an essay, performing calculation work, completing homework, etc.):*

№ s/n	Types of work submitted for independent work	Duration in hours IW
1	*Review of lecture material and study of questions assigned for independent work*	10
2	*Preparation for practical works*	18
3	*Preparation for laboratory works*	18
4	*Preparation for modular control work*	4
5	*Performance of computational and graphic work*	10
6	*Preparation for the Final test*	30
Total hours		90

Distribution of hours of independent work of students by educational content topics:

№ s/n	Titles of topics and questions to be studied independently and references to educational literature	Duration in hours IW
1	*Intel 8086 microprocessor. Coprocessor and arithmetic extension of the processor.* *The list of issues submitted for independent study: exception handling by the coprocessor (Stack Fault) [2, 4].*	5
2	*Program synchronization and timer control.* *List of questions submitted for independent study: interaction with the CPU through interrupts (IRQ) [2, 4].*	2
3	*Organization of memory and registers. Direct memory access.* *List of questions submitted for independent study: memory access using segments [2, 4].*	2
4	*Clock generator. Timers. Bus address and data.* *List of issues submitted for independent study: multiplexing of address and data buses [2, 4].*	2
5	*Organization of I/O ports.* *List of issues submitted for independent study: address space for I/O ports [2, 4].*	5
6	*Interfaces of external devices for interaction with technological equipment.* *The list of issues that are submitted for independent study: interruptions that can be masked (prohibited) [3, 5].*	5
7	*Interrupt controller. Organization of the mechanism of breaks.* *The list of issues submitted for independent processing: processing of requests (IRQs) and responses (INTA) by the interrupt controller [3, 5].*	2
8	*Means of organization of exchange with external devices. The scheme of conclusions.* *The list of questions submitted for independent study: cascading the operation of devices (master/slave) [3, 5].*	2
9	*Application of microprocessor engineering in medicine.* *The list of questions submitted for independent study: synchronization of the microcontroller program and external device [3].*	2
10	*Intel 8086 command system. Interrupt system. Memory addressing.* *List of questions submitted for independent study: command system of stack operations (SS) [3, 5].*	5
11	*MASM tools for software development.* *List of questions submitted for independent study: macros in programming in the Assembler language [3, 5].*	2
12	*Memory and register organization for Arduino UNO.* *List of questions submitted for independent study: special registers (SREG, GPRs) that control the timer and ADC [1, 6].*	2
13	*Organization of I/O ports.* *List of issues submitted for independent study: port registers that control input/output [1, 6].*	2
14	*Selection and connection of sensors and sensors.* *List of issues submitted for independent study: use of auxiliary components, such as resistors (e.g., 4.7kΩ for 1-Wire sensors) [1, 6].*	2
15	*Arduino processor programming in C/C ++.* *List of questions submitted for independent study: special libraries for LCD and 1-Wire sensors [1, 6].*	2

№ s/n	Titles of topics and questions to be studied independently and references to educational literature	Duration in hours IW
16	*Arduino IDE software.* *List of questions for independent study: built-in Arduino commands and their basic syntax in C++ [1, 6].*	2
17	*NI VISA components in LabVIEW 2010 for serial data I/O.* *List of questions submitted for independent study: LabVIEW Interface toolkit for Arduino [1, 6].*	2
18	*Modular test work*	4
19	*Computational and graphic work*	10
20	*Final test*	30
Total hours		90

One of the main types of semester control during the mastering of the discipline "Microprocessor Engineering" is the implementation of calculation and graphic work. Calculation and graphic work is performed in accordance with the requirements, within the period specified by the teacher.

The main purpose of computational and graphic work is to solve a practical problem using the material learned in lectures and independently, and practical skills acquired in practical work. The student can write calculation and graphic work only on the subject agreed with the teacher.

Approximate subject of calculation and graphic work:

№1 Modern microprocessors from Intel. Basic microprocessor 8086/8088.

№2 Microprocessor system architecture. Computer design features.

№3 General principles of building multiprocessor computers.

№4 Computer system resources. General characteristics.

№5 Organization of modern computer memory. General principles and composition of basic memory devices.

№6 Microprocessor interfaces. Basic principles of control of external devices.

№7 Pentium class microprocessors. Features of architecture.

№8 AMD microprocessors. Features of architecture.

№9 Mathematical coprocessors. Purpose and features of architecture.

The title page of the calculation and graphic work should have the following content: the name of the university; name of the faculty; name of department; name of specialty, name of educational-professional program, name of academic discipline; theme of calculation and graphic work; surname and name of the student, course, number of the academic group, year.

The title page is followed by a detailed plan (content) of the calculation and graphic work, which should highlight the introduction, sections of the main content (main topics studied), their subdivisions (if necessary), conclusion, list of sources used. The table of contents on the right indicates the page numbers at the beginning of each question. Each section begins on a new page.

The total amount of calculation and graphic work, depending on the chosen topic can vary from 25 to 40 pages of the main text (in consultation with the teacher). The amount of computational and graphic work is determined by the student's ability to briefly and at the same time comprehensively explain and analyze the program code in the Code Composer Studio environment.

Mandatory requirement: clear reference to sources of information. All figures, facts, opinions of scientists, quotations, formulas should have a reference in the form [2, p. 54] (the first digit means the number of the source in the list of references given at the end of the creative work, and the second digit -

the page number in this source). It is desirable to use tables, diagrams, graphs, charts, etc. The list of used sources (not less than 10 sources) is made out according to operating rules. If the information is taken from the Internet, you need, as for ordinary literature, specify the author, the title of the article, and then provide the address of the site on the Internet.

Calculation and graphic work is evaluated by the following criteria: logic of the plan; completeness and depth of topic disclosure; reliability of the received data; reflection of practical materials and results of calculations; correctness of formulation of conclusions of the received results and conclusions; design; substantiation of the student's own opinion on this issue in the form of a conclusion.

Deadline for submission of calculation and graphic work for verification: 15-16th week of study.

Calculation and graphic work is not tested for plagiarism, but must meet the requirements of academic integrity. In case of academic dishonesty, the work is canceled and not checked.

Policy and control

7. Policy of academic discipline (educational component)

Attending classes

Attendance at lectures is optional. Attending practical classes is desirable, as they are used to write express tests / tests, as well as to defend practical work.

The grading system is focused on obtaining points for student activity, as well as performing tasks that are able to develop practical skills and abilities.

Control measures missed

Missed control measures (defense of practical work) must be practiced in the next classes, provided that the task is scheduled for the current lesson, or in consultations.

Omissions of writing a module test and express test are not fulfilled.

Calculation and graphic work, which is submitted for inspection in violation of the deadline is evaluated with a decrease in the number of weight points.

Violation of deadlines and incentive points

Encouragement points		*Penalty points **	
Criterion	*Weight points*	*Criterion*	*Weight points*
Improving practical work	*1 points (for each practical work)*	*Untimely implementation and test of practical work*	*From -0.5 points to -5 points (depending on the delivery date)*
Passing distance courses on topics that are agreed with teachers	*5 points*	*Untimely execution and test of calculation and graphic work*	*From -2 points to -20 points (depending on the construction period)*
Registration of scientific work for participation in the competition of student scientific works	*10 points*		
Writing abstracts, articles, participation in international, national and / or other events or competitions on the subject of the discipline	*5 points*		

** if the control measure was missed for a good reason (illness, which is confirmed by a certificate of the established sample) - penalty points are not accrued.*

Academic integrity

The policy and principles of academic integrity are defined in Section 3 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". Read more: https://kpi.ua/code.

Norms of ethical behavior

Normative principles of behavior of students and employees, defined in sections 2 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". Read more: https://kpi.ua/code.

Procedure for appealing the results of control measures

Students have the opportunity to raise any issue related to the control procedure and expect it to be addressed according to predefined procedures.

The student has the right to appeal the results of the control measure according to the approved provision on appeals in the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (approved by the order №NON/128/2021 from 20.05.2021) - https://osvita.kpi.ua/index.php/node/182

Inclusive education

The discipline "Medical Microprocessor Systems" can be taught to most students with special educational needs, except for students with severe visual impairments who do not allow to perform tasks using personal computers, laptops and / or other technical means.

Distance learning

Distance learning takes place through the Sikorsky Distance learning Platform «Sikorsky».

Distance learning through additional online courses on certain topics is allowed subject to agreement with students. If a small number of students wish to take an online course on a specific topic, studying the material with such courses is allowed, but students must complete all the tasks provided in the discipline.

The list of courses is offered by the teacher after the students have expressed a desire (because the bank of available courses is updated almost every month).

The student provides a document confirming the completion of the distance course (in the case of a full course) or provides practical tasks from the distance course and subject to an oral interview with the teacher on the topics can receive grades for control measures provided for the studied topics (express control / test tasks, practical work).

Performance of practical works, and also performance of settlement and graphic work, is carried out during independent work of students in a remote mode (with a possibility of consultation with the teacher through e-mail, social networks).

Learning a foreign language

Teaching in English is carried out only for foreign students.

At the request of students, it is allowed to study the material with the help of English-language online courses on topics that correspond to the topics of specific classes.

8. Monitor and evaluate the system of evaluation of learning outcomes (Rating System of Evaluation)

Evaluation system (current control):

№ s/n	Control measure	%	Weight points	Number	Total
1.	Express control works / test tasks	10	2	5	10
2.	Execution and test of practical works	24	2	12	24
3.	Execution and test of laboratory works	36	4	9	36
4.	Modular control work (MCW)	15	15	1	15
5.	Calculation and graphic work (CGW)	15	15	1	15
6.	Test work[1]	80	80	1	80
	Total				100

Calendar control *(CC) - is performed twice a semester as monitoring of the current state of compliance with syllabus requirements.*

The purpose of calendar control is to improve the quality of student learning and monitor the implementation of the schedule of the educational process by students.

Criterion			The first CC	The second CC
Deadline of calendar controls			8th week	14th week
Conditions for obtaining a positive result from the calendar control	Current rating		≥ 24 points	≥ 42 points
	Execution practical work	PW № 1- 5	+	+
		PW № 6-12	-	+
	Execution of laboratory works	LW № 1- 4	+	+
		LW № 5- 9	-	+
	Express control works / test tasks	At least 4 of any lectures	+	-
		At least 8 of any lectures	-	+
	Modular control work	Estimated MCW	-	+
	Calculation and graphic work	Estimated CGW	-	-

In case of detection of academic poor quality during training - the control measure is not credited.

Semester certification of students

Mandatory condition for admission to the test		Criterion
1	Current rating	RD ≥ 42
2	Obtaining a positive assessment for the performed calculation and graphic work	More than 8 points
3	All practical works are tested	More than 14 points
3	All laboratory works are tested	More than 14 points
4	Writing at least 6 express tests / tests	More than 6 points

The results are announced to each student separately in the presence or remotely (by e-mail). Also recorded in the system "Electronic Campus".

Optional conditions for admission to closure:

1. *Activity in practical classes.*
2. *Activity in laboratory classes.*
3. *Positive result of the first attestation and the second attestation.*
4. *Attending 50% of lectures.*

Table of translation of rating points to grades on a university scale:

[1] *Taken into account in the amount of the rating together with the grade for CGW in case the student has not scored 60 points per semester or he wants to improve his grade.*

Number points	Assessment on the university scale
100-95	Perfectly
94-85	Very good
84-75	Good
74-65	Satisfactorily
64-60	Enough
Less 60	Unsatisfactorily
Admission conditions are not met	Not allowed

9. Additional information on the discipline (educational component)

Appendix 1. Program learning outcomes (extended form)

In accordance with the Order of the Ministry of Education and Science of Ukraine No. 1204 dated November 19, 2018 "On approval of the standard of higher education in the specialty 163 Biomedical Engineering" for the first bachelor's level of higher education", in Appendix 1 establishes the correspondence of learning outcomes to competencies in the discipline "Microprocessor Engineering".

Appendix 2. The list of questions for preparation for module control work

The list of questions for preparation for modular control work, and also for preparation for credit is given in Appendix 2.

Distance learning through additional online courses on certain topics is allowed subject to agreement with students. If a small number of students wish to take an online course on a specific topic, studying the material with such courses is allowed, but students must complete all the tasks provided in the discipline.

The list of courses is offered by the teacher after the students have expressed a desire (because the bank of available courses is updated almost every month).

The student provides a document confirming the completion of the distance course (in the case of a full course) or provides practical tasks from the distance course and subject to an oral interview with the teacher on the topics can receive grades for control measures provided for the studied topics (express control / test tasks, practical work).

Work program of the discipline (syllabus):

Compiled by *Associate Professor of Biomedical Engineering, Doctor of Technical Sciences, Shlykov Vladyslav Valentynovych, Head of the Department of Biomedical Engineering.*

Approved by *the Department of Biomedical Engineering (protocol № 16 of June 21, 2024)*

Approved by *the Methodical Commission of the Faculty of Biomedical Engineering (protocol № 9 of June 26, 2024)*

Appendix 1.

For syllabus of the discipline "Microprocessor Engineering"

Program learning outcomes (extended form)

As a result of studying the academic discipline "Microprocessor Engineering", students will be able to:

Learning outcomes (PRN)		Compliance of Learning Outcomes with Competencies according to the Higher Education Standard [6]	
		General Competencies (**soft skills**)	Special Competencies (**professional**)
PRN 2	*Formulate logical conclusions and reasoned recommendations regarding the assessment, operation, and implementation of biotechnical, medical-technical, and bioengineering tools and methods.*	*ZK 1 - Ability to apply knowledge in practical situations.*	*FK 7 - Ability to plan, design, develop, install, operate, maintain, service, control, and coordinate the repair of devices, equipment, and systems for prevention, diagnosis, treatment, and rehabilitation used in hospitals and research institutes.*
PRN 4	*Apply the provisions of regulatory and technical documents governing the procedure for product certification, production certification.*	*ZK 10 - Skills in conducting safe activities.*	*FK 12 - Ability to ensure and monitor compliance with safety and biomedical ethics when working with medical equipment.*
PRN 7	*Provide engineering support, service, and technical maintenance during the operation of laboratory analytical equipment, medical diagnostic and therapeutic complexes and systems in accordance with the rules established by technical documentation and regulatory documents governing the procedures for commissioning, application, and repair of medical equipment, as well as to form the standard documentation by types of work according to the technical regulation on medical devices.*	*ZK 2 - Knowledge and understanding of the subject area and understanding of professional activities.*	*FK 2 - Ability to provide engineering and technical expertise in the planning, development, evaluation, and specification of medical equipment.*
PRN 12	*Provide recommendations for selecting equipment to facilitate diagnosis and treatment.*	*ZK 1 - Ability to apply knowledge in practical situations.* *ZK 3 - Ability to communicate in the official national language both orally and in writing.*	*FK 7 - Ability to plan, design, develop, install, operate, maintain, service, control, and coordinate the repair of devices, equipment, and systems for prevention, diagnosis, treatment, and rehabilitation used in hospitals and research institutes.*

Learning outcomes (PRN)		Compliance of Learning Outcomes with Competencies according to the Higher Education Standard [6]	
		General Competencies (**soft skills**)	Special Competencies (**professional**)
PRN 18	*Understanding of fundamental-applied, medical-physical, and physico-chemical principles governing the functioning of biological objects, as well as bioengineering fundamentals of technologies and equipment for researching human body processes.*	*ZK 2 - Knowledge and understanding of the subject area and understanding of professional activities.* *ZK 5 - Ability to conduct research at an appropriate level.*	*FK 1 - Ability to apply engineering software packages for research, analysis, processing, and presentation of results, as well as for automated design of medical devices and systems.*

[6] Order of the Ministry of Education and Science of Ukraine No. 1204 dated November 19, 2018 "On approval of the standard of higher education in the specialty 163 Biomedical Engineering" for the first bachelor's level of higher education".

Appendix 2.

For syllabus of the discipline "Microprocessor Engineering"

The list of questions for preparation for module control work,

And also for preparation for test

1. To analyse the Harvard architecture of microprocessors.
2. To analyse the bus assignment: address bus, data bus, control bus.
3. Compare the RISC and CISC architectures. Definition and specialization.
4. To analyse the structure of the built-in microcontroller.
5. To give the analysis of modularity of microprocessor system. System bus.
6. Give examples of adding integers. Command syntax.
7. Give examples of subtraction of integers. Command syntax.
8. Give examples of multiplication of integers. Command syntax.
9. Give examples of division of integers. Command syntax.
10. Give examples of arithmetic shift to the left and right. Command syntax.
11. Give examples of unconditional transition and comparison of operands. Command syntax.
12. Give examples of using the conditional transition command. Conditions of transition.
13. Give examples of logical operations. Command syntax.
14. Give examples of the command cyclic shift to the left.
15. Give examples of the command cyclic shift to the right.
16. Give examples of the team organization of cycles. Command syntax.
17. Give examples of the use of prefix repetition of data transfer commands.
18. Give examples of commands to set and reset flags.
19. Give examples of the command to move along the line.
20. Give examples of loading the address of a variable in memory.
21. Give examples of basic addressing. Segment address.
22. The use of index addressing with a shift. Effective operand address.
23. Application of base-index addressing. Forming an address in memory.
24. Give examples of using an effective address when working with arrays.
25. Give examples of the use of routines. Command syntax.
26. Use of general purpose registers. The composition of the operating device.
27. The use of segment registers. The composition of the bus interface.
28. Use of index registers. Register of flags.
29. Give the functions of the ALU. Assignment of ALU address inputs.
30. Assign buffer address and command buffer.
31. Provide a scheme of direct addressing of I/O to the port.
32. Provide a scheme of indirect addressing of I/O to the port.
33. Give examples of I / O commands in / out port. Command syntax.
34. To analyse the I/O procedure in / from the file. Example.
35. To analyse the compatibility of the interface of the i8086 processor with the system bus.
36. Turn on the i8086 processor in the minimum mode.
37. Provide the scheme of inclusion of the i8086 processor in the maximum mode.
38. To analyse the organization of memory. Address space.
39. To analyse the structure of the i8086 processor. Executive module.
40. To analyse the structure of the i8086 processor. Bus interface.
41. To analyse the structure of the i8086 processor. Management and timing.
42. Provide a diagram of the module of the dynamic memory controller.

43. To analyse the functions of the I/O interface.
44. To analyse the increase in memory of the microcontroller.
45. Give examples of the break command by vector type. Command syntax.
46. Give examples of the overflow break command. Command syntax.
47. To analyse returns from breaks and routines.
48. To analyse the segmental organization of memory.
49. To analyse the formation of the physical address of the byte in memory.
50. To analyse the formation of a logical address.
51. Give examples of programming the I/O mode in the port.
52. Give an example of a break call. Addresses of break functions.
53. To analyse data exchange management. Software exchange.
54. To analyse data exchange management. Exchange on a break.
55. To analyse the functions and purpose of the coprocessor.
56. To analyse the purpose of arithmetic expansion of the processor.
57. To analyse the functions and purpose of the timer.
58. Give examples of timing of timer signals.
59. Give examples of addressing I/O ports.
60. Give the structure of the parallel I/O interface.
61. Give the structure of the serial I/O interface.
62. Give the wiring diagram of the clock generator.
63. To analyse the block diagram of the programmable timer.
64. Specify the operating modes of the programmable timer.
65. To analyse the work of the break controller. Source of interruptions.
66. Give examples of interrupt requests. Types of break vectors.
67. Give the circuit diagram of the microprocessor i8086.
68. To analyse the addressing of an 8-bit device organization of the exchange.